CONTRIBUTIONS TO THE LIFE HISTORIES OF PLANTS. No. III.

BY THOMAS MEEHAN.

Smilacina bifolia. Observing in a large tract of *Smilacina bifolia* that the leaves were for the most part at a very light angle, indeed almost vertical, it seemed to afford a good opportunity to test a prevalent idea that, in such cases, the stomata are nearly equal in numbers on each surface of the leaf. Dr. J. B. Brinton kindly made a careful microscopical examination of some leaves I furnished him with, but he found no difference in this respect to leaves with a purely horizontal direction. On a small section, of which he hands me a drawing, there was only one stoma on the upper surface, while there were fifteen on the under surface.

Dichogamy and its significance. Dichogamy has reference to the relative period of maturity of stamen and pistil. When the stamens are in the advance the flowers are said to be proterandrous; when the pistil is mature before the stamens, the flower is proterogynous. Usually the term is employed in connection with hermaphrodite flowers. But as it is a mere question of the time required for the development of the sexual organs necessary to the perfecting of a complete individual, it is obvious that we may extend the term so as to include monœcious and diœcious plants.

The law under which the separate sexual organs are retarded in their growth in some instances and accelerated in others, cannot but have supreme importance in the study of vegetable biology. If we can trace the working of this law in the hermaphrodite flower to the extent of acceleration or retardation for but a single day, we can easily get to understand how some plants may come to have the maturity of these organs days apart, and to finally divide into monoecious or dioecious classes.

Among the contributions I have made to botanical science, few impress me with more importance than the determination of the fact that a degree or measure of heat capable of exciting the male organs to growth, may yet be wholly inadequate to start growth in the female (see *Proceedings of the Academy of Natural Sciences* 1885, *p.* 117.)

I observed that the aments of walnuts, hazel-nuts and similar plants were often perfected weeks and occasionally months before the female flowers were in conditon to receive pollen, and that it

was only in seasons when the stamens and pistils matured simultaneously, that large crops of nuts followed. I had overlooked at that time, the fact that something similar had been placed on record before. In the *Transactions of the Horticultural Society of London*, vol. v, 1824, is a paper by Rev. George Swayne, showing that the filbert crop in Kent fails two years out of five; that some seasons the catkins mature before the female flowers open, and at others not till afterwards, and that failure to produce a crop results from the absence of pollen at the period when the female flower is in receptive condition. All I can, therefore, claim as original is the formula that varying measures of heat influence variously the separate sexes,—the smaller measure influencing the male, while the female still continues to rest.

Since my observations were made on the hazel, I have extended them to other plants. It has long been known that in many of the Central States coniferous trees that produce seeds abundantly farther north, rarely have one perfect seed in those regions. I know this is so in the vicinity of Philadelphia. The Norway spruce may produce cones by the cart-load, with not an ounce of seed in the lot. Since the observations above cited I find that the male flowers mature long before the female, and affords a satisfactory reason for the failure. Further north, where winter does not coquette with spring as here, they remain in rest equally, and advance together. In their gregarious, forest condition, no doubt the extent of surface conduces to an equilibrial condition of climate not surrounding isolated trees in a cultivated state.

In brief, I may enumerate a number of coniferæ, alders, walnuts, chestnuts, oaks, hickories and the hazel-nut as among those that I carefully watched for the few years past, noting a wide range of difference each season between the times of maturing of the male and female flowers. The season of 1887–8, I noticed was favorable to a simultaneous maturity of the sexes. I exhibited specimens in the spring of 1888, to the Botanical Section of the Academy, and had no difficulty in predicating on the fact of simultaneity an abundant harvest of nuts, which has been fully realized. I have since been observing the working of this principle in elms and maples—hermaphrodite plants; the species under observation being *Ulmus americana*, and *Acer dasycarpum*. The trees of the former were comparatively young, but had flowered the first three years without perfecting more than a seed here and there. I had no

difficulty in perceiving in these elms and maples in the spring of 1887, that the pollen had been dispersed weeks before the pistil was mature. The past season (1888) examination showed the anthers bursting simultaneously with the receptive conditions. There was an abundant crop of seeds. The maple is usually inclined to dicœcism. Although the flowers may seem perfect, the stamens in some fertile flowers never proceed beyond anthers that give no pollen, while in other cases perfect stamens with filaments and fertile anthers are produced, when the gynœcium seems unable to fulfil its functions. But the elm, at least here, seems a full hermaphrodite, yet only this season of three successive ones, had it full hermaphrodite functions. In the two first it was so very proterandrous as to be barren. It was not proterandrous this year, though I cannot say it was proterogynous. It was, in fact as well as in name, hermaphrodite.

Surely I am warranted in presenting the formula, that varying measures of temperature variously affect the separate sexual organs, and that the dichogamy has its origin in this simple circumstance.

It is interesting to note how near we may get to a great truth without actually perceiving it till long afterwards. In 1868, I announced, through the Proceedings of the Academy, my discovery that *Mitchella repens* was not merely heterostyled but practically dioecious. I had subsequently found a white-berried variety which bore berries freely when surrounded by its companions, but I never had one during the many years it was under culture in my garden. Up to that time and subsequently, the course of these phenomena was obscure. Mr. Darwin, in *Forms of Flowers* (Chap. VII), observes: "But according to Mr. Meehan *Mitchella* itself is dioecious in some districts. * * * Should these statements be confirmed, *Mitchella* will be proved to be heterostyled in one district and dioecious in another." With our present light we can readily see how this may easily be.

Now what is the significance of dichogamy? The general view at the present time is substantially the same as given in the work above quoted. There Darwin expresses it in these words: "Various hermaphrodite plants have become heterostyled, and now exist under two or three forms; and we may confidently believe that this has been effected in order that cross-fertilization should be assured."

With the new light I have thrown on the origin of dichogamy, I am sure the great Darwin would be ready to modify this view. It cannot have the significance we all thought it had at that time.

We now see that a plant may find itself in a climate or in surroundings favorable to an early development of stamens; in another case in a locality or country where the reverse will prevail. Dichogamy will then vary. We also know that heredity plays a part in fixing a constantly recurring local tendency, so that a plant having acquired a tendency to proterandy or it may be to proterogyny, would continue to carry the habit long after the superinducing causes had passed away. Plants remaining for ages in a locality where the conditions would be favorable to a wide difference between simultaneity, would probably become in time monœcious or diœcious, and all this, as we see, from no particular assurance that cross-fertilization would thereby be affected.

In trying to reach generalizations of this character, we should not, however, forget that in nature, things seldom follow from a single cause, but from the operation of united forces. In this connection I have shown, (see Proceedings of the *American Association for the Advancement of Science, Salem*, and subsequent meetings,) that sex itself is largely influenced by the amount of nutrition available when the primordial cell is fertilized. If sex itself may be influenced by nutrition, the subsequent growth of its representative organs may still further be influenced, which would introduce into the consideration an additional element aside from temperature alone.

I have my own postulate as to the significance of dichogamy. I rest here by the simple proposition that whatever its significance, it arises from no effort innate to the plant itself, but from an outside force that can have little interest in cross-fertilization.

(It is proper to say that an abstract of this paper was read before the *American Association for the Advancement of Science,* at Cleveland. See *Botanical Gazette* for September 1888.)

Trientalis Americana, Pursh. There can be but little doubt that *Trientalis Americana* grew freely over what is now the city and county of Philadelphia. It is still found in adjoining counties, and here and there are old botanists who remember having collected it on the confines of the county; but it is not included in Barton's Flora, now over 60 years old,—nor in Darrach's Catalogue, or any published list so far as I know. In an old chestnut wood at Chestnut Hill, my brother Joseph detected a small patch this summer, that has evidently been there for ages, but overlooked,—and this suggests some thoughts on its habits and past geographical record of general interest.

I have collected this plant in its various forms over widely separated portions of the American continent,—Canada, the Alleghanies, California and Alaska,—and though holding its own wherever found, it does not show evidences of the extension that must have characterized it in the past, when, with no remarkably specialized organs favoring distribution, it managed to travel in its various forms—as *T. Europæa*, *T. Americana* and *T. Arctica*—over the whole north of Europe and across the American continent to Behring's Straits. So far as I have seen in the localities named, the plants seem to produce seeds, though not abundantly; but there are no evidences of seedlings. In the Chestnut Hill location, the only tract on which the plant is found is but a few hundred square feet, yet though unnoted, it must have been confined to this limited area for at least a hundred years, or perhaps for many centuries. The piece of wood is a favorite botanical hunting ground. I myself have wandered through it for over a quarter of a century, and the early Philadelphia botanists—sharp-eyed as they were—would surely have seen it here if at all common in those times. It is worth while considering how so great a wanderer in remote ages should have acquired such remarkable stay-at-home habits in recent times. Some conditions favorable to distribution must surely have existed, which have disappeared in modern ages. What can these changes be?

So far as persistency is concerned I note a fact, not recorded anywhere, that the plant is stoloniferous, bearing a small tuber at the end of a slender thread, which reproduces the plant next year, the whole of the previous years' plants, except these little tubers, dying away. In this way the plant, through its progeny, can be a traveler at the rate of two or three inches a year. It is remarkable that this character is not noted by systematic authors, for the specimens in the herbarium of the Academy taken at various times during the flowering period, from different parts of the world, exhibit traces of the little tubers at the ends of stolons that have evidently been passed over for true roots. It is hardly to be supposed that the plants have wandered wholly by the aid of these little tubers, valuable as they must be for persistency when once a foot-hold has been obtained. We are forced to the conclusion that at some former period it received much more aid from seed and seedlings than it receives in modern times.

As we are often aided in the study of the geographical wanderings of plants, a list is appended of comparatively local plants, found in companionship with *Trientalis* on the 3rd of June.

Allium Canadense
Amelanchier Botryapium
Cypripedium pubescens
Hypoxys erecta
Mediola Virginica
Mitchella repens
Goodyera pubescens
Osmunda spectabilis
Oxalis violacea
Pogonia verticillata
Polemonium reptans
Pyrola elliptica
Pyrus arbutifolia
Viburnum acerifolium
Viola pubescens
Veratrum viride
Aspidium cristatum.

On the glands in some Caryophyllaceous flowers. It cannot be said that the existence of glands near the base of the common chickweed and its allies, has been wholly overlooked, but they are seldom referred to, and no attempt has been made to read their significance.

In regard to the chick-weed, *Stellaria media*, Withering notes in the *British Flora* (p. 547) "stamens glandular at the base." Dr. Bromfield notes of a closely related species, *Stellaria uliginosa*, "stamens 10, those alternating with the petals inserted on shortish, flattened glands; near, but not close to the base of the germen; being, in fact, above the latter and at the top of the conical enlargement of the calyx below the sepals" (*Flora Vectensis* 71). At p. 75, the same author notes of *Arenaria serpyllifolia* "stamens 5 to 10, those alternating with the sepals placed on a projecting glandular base, five shorter, having apparently abortive anthers." Of *Honckenya peloides*, both Torrey and Gray and Withering note the ten glands alternating with the stamens; and Hooker remarks of *Cherleria sedoides* that it has glands inside the five stamens.

Examining with a pocket lens, some flowers of the chickweed, between two and three o'clock in the afternoon early in May, I noticed the glands had secreted an enormous amount of liquid. The little globules were nearly as large as ordinary pin heads. It did not occur to me, at that time, that the period of the day had anything to do with the phenomena, but I was led to examine other allied species of plants the next day. I did not detect any, and I particularly examined *Cerastium viscosum* and had about concluded that the existence of prominent glands and a free exudation of liquid was peculiar to the chickweed, when, examining about the

same time of day as in the former case, I found the exudation as abundant in the *Cerastium* also. Profiting by this hint, and examining at this time of day all species coming under my notice, I can say that glands exist in *Cerastium viscosum*, *C. arvense*, *Arenaria serpyllifolia*, *Stellaria longifolia*, *S. media;* I could not find the glands in *Stellaria pubera.*

It is well known that in Caryophyllaceæ generally, there are usually ten stamens, in two series,—the outer alternate with the petals,—the inner five alternate with the outer, and opposite the petals. There are often less by abortion, in which case it is the members of the inner series that disappear. No glands are between the stamens of the inner series. There are never but five, and these alternate with outer stamens. The outer series mature the anthers a day before the inner series mature them (except, I believe, in *S pubera*) ; but the liquid exudation occurs with the maturity of the anthers of the first series.

The liquid (in the chickweed) has a slightly sweet taste, and is very viscid, as a little taken out with the point of a pen-knife and rubbed between finger and thumb, testifies.

The five outer stamens in *Arenaria serpyllifolia* bend inwards, and the abundantly polliniferous anthers rest on the apex of the stigmas, completely covering the stigmas with own-pollen. The inner ones turn outwardly, resting on the petals or nearly so, and seem to have anthers wholly destitute of pollen. In *Cerastium viscosum*, the pollen matures before the pistils. At the time the pollen scatters, the fasicle of pistils are keeping close company. Soon afterwards they diverge, push themselves up among the pollen-clothed stamens, and are certainly self-fertilized in most, if not absolutely in all cases.

Examining the chickweed as it grew over a very large tract of waste ground, and soon after noon, when with a close naked-eye observation the comparatively large globules can be seen glistening in the sun,—one can scarcely neglect asking nature the chief object of this enormous production of sweet liquid,—for the collective quantity from these millions of flowers may be truly styled enormous. It has been asserted that nectar is given to flowers to attract insects for the purpose of cross-fertilization, and many observations confirm the deduction in numerous instances. Certainly the nectar attracts and as certainly the visits often result in fertilization—sometimes by the flowers' own pollen, oftener by the pollen from flowers on the same or neighboring plants, and occasionally from flowers from

plants under different conditions, the true Darwinian idea of cross-fertilization. But I could see no bees visiting the chickweed for this banquet of nectar set before them. As the flowers are arranged for self-fertilization, there could be no assistance to the flowers in this work even did bees visit them. If insects came, in no way does it appear they could be of any advantage. Because I did not see any bees using the nectar during warm days following the first observations, it does not follow that they never resort to it. Bees go to those flowers where their hard task is the easiest. I have often seen them collecting pollen from chickweed, when a few warm early spring days attracted them from the hive, but at soon as the male catkins of the willow mature, with their very abundant crop of pollen, they leave the chickweed, and indeed most other flowers, while the willow pollen lasts.

Later on, about the middle of May, I found nectar-collecting honey bees working freely on *Cerastium viscosum*. It is never safe to say bees or other insects do not visit certain flowers. It depends largely on the supply of material. When abundant they evidently have preferences, and let the more difficult tasks alone.